FLEXURAL STRENGTH OF CONCRETE (USING SIMPLE BEAM WITH THIRD-POINT LOADING)
FOP FOR AASHTO T 97

02

Scope

This test method covers the determination of flexural strength of concrete using a simple beam with third-point loading.

The most commonly tested beam size is one having a nominal width and depth of 6 inches and a length of at least 20 inches.

Apparatus

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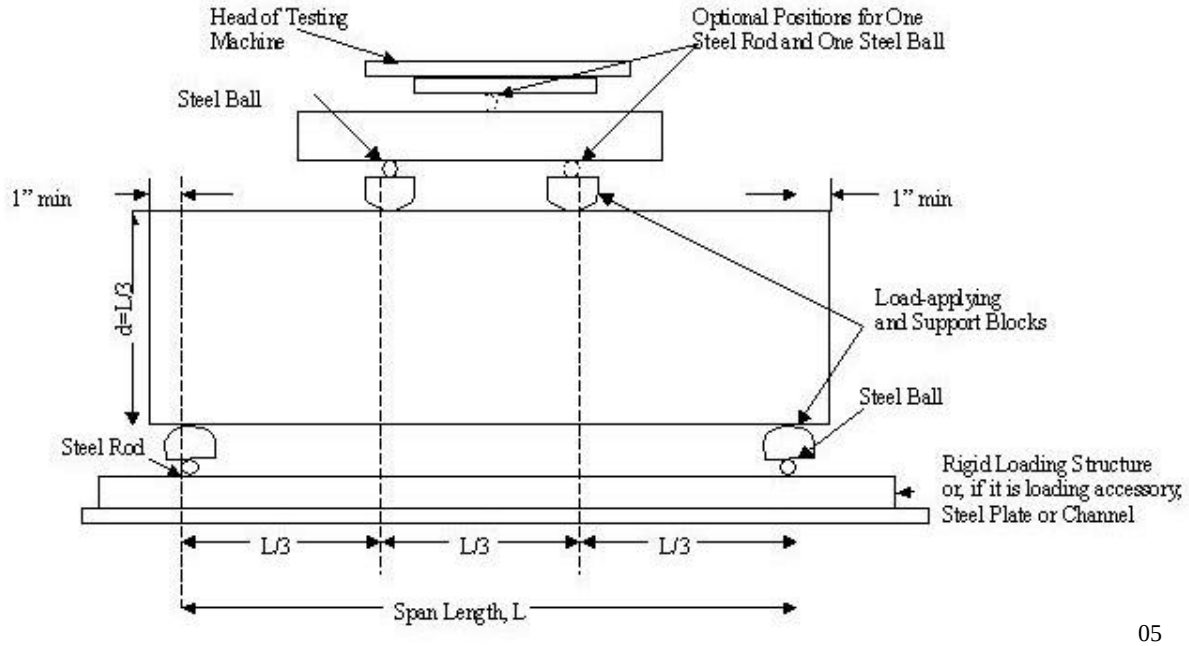
- **Testing Machine:** Capacity sufficient to cause specimen failure at prescribed loading rates. The machine shall be either power operated or of the hand operated pump variety such that a single stroke of the pump is sufficient to apply the entire load to specimen failure at the prescribed rate. The apparatus must apply the load continuously and without shock. The machine shall be accurate such that the percentage of error shall not exceed ±1.0 percent of the indicated load.
- **Loading Apparatus:** Suitable to insure that applied loads will be perpendicular to the face of the specimen and applied without eccentricity. See FIGURE 1 for a typical acceptable apparatus. The apparatus must be capable of maintaining the specified span length and loading points within 0.05” of that specified.

  Load-applying and support blocks must extend across at least the full width of the specimen. The shape of each block shall be a portion of a cylinder, the axis of which is coincident with either the axis of the steel rod or ball on which it pivots. The bearing surfaces shall be case hardened and shall not depart from a plane by more than 0.002” The load-applying and support blocks must be maintained in a vertical position and in contact with the steel rod or ball with spring-loaded screws.

Figure 1



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Note 1: The support blocks and loading blocks must bear on a steel rod at one location and one steel ball at the opposite location.

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- **Feeler Gages:** Of 0.004" and 0.015" thickness, used for measuring gap between test specimen and load-applying or support blocks.
- **Leather Shims:** Uniform thickness of ¼ inch, 1 to 2 inches in width, extending across the entire bearing width of the specimens.

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Specimens

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Specimens shall comply with all applicable provisions of either AASHTO T 23 or T 126.

The test span may not depart by more than 2% of being three times the specimen depth as tested.

The sides of the specimens must be at right angles to the top and bottom. The bearing surfaces must be smooth, free of scars, holes, and indentations.

Table 1
Permissible Time Tolerances

Specified Age	*Tolerance*
12 hrs	15 min (2.1%)
24 hrs	30 min (2.1%)
3 days	2 hrs (2.8%)
7 days	6 hrs (3.6%)
28 days	20 hrs (3.0%)
90 days	2 days (2.2%)

$$\frac{3d-S}{S} \times 100 < 2\%$$

Where:
d = specimen depth as tested
S = test span, distance between supports

Procedure

1. All test specimens for a given test age shall be broken within the permissible time tolerances prescribed in Table 1.
2. Flexure tests of moisture-cured specimens shall be made as soon as practicable after removal from moist storage. Specimens shall be kept moist by any convenient method until tested.
3. Place the test specimen in the apparatus by turning the specimen on its side so that the sides as molded become the top and bottom against which the loading and support blocks will bear.
4. Apply a load between 3 and 6% of the anticipated ultimate load.
5. Determine that full bearing is achieved between all four blocks and the specimen. If full bearing is achieved, the specimen may be tested as is without the use of leather shims or capping.

   If there is any gap 1 inch or more in length exceeding 0.004 inches but not greater than 0.015 inches, leather shims may be used to accommodate proper specimen bearing.

   If there is a gap 1 inch or more in length exceeding 0.015 inches, the specimen must be ground or capped such that the bearing surfaces meet the required specifications.
6. No loose particles may be trapped between the test specimen and any bearing point, or between shims and bearing points during application of the test load.

7. Apply the load continuously and without shock. Control the rate between 125 and 175 psi per minute when calculated according to the formulas under "Calculation" below.

16 **Measurement of Test Specimens After Test**

17 Take three measurements across each dimension (one at each edge and one at the center) to the nearest 0.05 inches to determine specimen width, depth, and location of the fracture. Fracture location is to be measured along the bottom face as oriented for testing.

If the fracture occurs in a capped section, include the cap thickness in the measurement.

Calculation

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- If the fracture occurs within the middle third of the span length, calculate the modulus of rupture according to the following formula:

  $$R = Pl/bd^2$$

  where:

  R = modulus of rupture, psi
  P = maximum applied load, lbf
  l = span length, in.
  b = average specimen width, in.
  d = average specimen depth, in.

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- If the fracture occurs outside of the middle third of span length by not more than 5%, calculate the modulus of rupture as follows:

  $$R = 3Pa/bd^2$$

  where:

  a = average distance between line of fracture and the nearest support measured on the tension face (bottom) of the beam, in.

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- If the fracture occurs outside of the middle third of span length by more than 5% of span length, discard the results of the test.

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Report

- Results shall be reported on standard forms approved for use by the agency
- Identification number
- Specimen age
- Average width to the nearest 0.05”
- Average depth to the nearest 0.05”
- Span length, in.
- Maximum load
- Modulus of rupture to the nearest 5 psi
- Curing history and apparent moisture condition at time of test
- If specimen was capped, ground, or if leather shims were used
- Observed defects in specimens
- Age of specimen.

Tips!

- Support blocks must bear on a steel rod at one span support and on a steel ball at the other. Loading blocks may also be required to conform to this configuration (see Figure 1 and explanatory notes in T 97)
- Remember to check for gaps between beam and apparatus bearing surfaces using feeler gages. Use leather shims or cap specimens as required.
- Measure location of failure along the bottom side of the beam as tested.
- Modulus of rupture is calculated and reported to the nearest 5 psi.

Calculation Examples

Calculate modulus of rupture according to one of the following formulas:

1. When fracture is within the middle third of span:

$$R = Pl / bd^2$$

where:

R = modulus of rupture, psi.
P = maximum applied load, lbf
l = span length, in.
b = specimen width, in.
d = specimen depth, in.

2. When fracture is outside the middle third of span by not more than 5%:

$$R = 3Pa / bd^2$$

where:

a = distance between line of fracture and nearest support, in.

Example #1 (Fracture within the middle third of span) 25

Maximum Load (P): 8,520 lbs.
Span Length (l): 18.00”
Specimen Width (b): 6.10”
Specimen Depth (d): 6.05”

$$R = 8520 \times 18 / 6.10 \times 6.05^2$$

$$R = 153360 / 223.28 = 687, \text{ say } 685 \text{ psi}$$

Example #2 (Fracture not more than 5% outside of middle third of span) 26

Maximum Load (P): 8,520 lbs.
Span Length: 18.00”
Distance of Fracture From Nearest Support (a): 5.75” (1.4%)
Specimen Width (b): 6.10”
Specimen Depth (d): 6.05”

$$R = 3 \times 8520 \times 5.75 / 6.10 \times 6.05^2$$

$$R = 146970 / 223.28 = 658, \text{ say } 660 \text{ psi}$$